

CLAIMS

What is claimed is:

- 1 1. A method for oxidizing a fuel, comprising:
2 providing a catalyst mixture including at least one compound having at least one
3 element selected from the group consisting of group III and group IIA, and
4 at least one compound having at least one element selected from the group
5 consisting of group IA, group IVA, group VI, group VII, group VIII,
6 group IB, group IIB and combinations thereof;
7 mixing a portion of the catalyst mixture with combustion air prior to mixing the
8 catalyst mixture with a fuel to be oxidized; and
9 oxidizing the fuel.
- 1 2. The method of claim 1, further comprising adding a liquid to the catalyst mixture
2 before mixing it with the combustion air.
- 1 3. The method of claim 2, wherein the liquid comprises one or more liquids from the
2 group consisting of ethylene glycol and water.
- 1 4. The method of claim 3, wherein the liquid further comprises lithium chloride.

- 1 5. The method of claim 1, further comprising sparging a gas through the catalyst
2 mixture to generate fluidized catalyst particles to mix with the combustion air.
- 1 6. The method of claim 5, further comprising ionizing the sparging gas prior to
2 sparging it through the catalyst mixture.
- 1 7. The method of claim 5, wherein the sparging gas is selected from the group
2 consisting of air, helium, nitrogen, argon, and combinations thereof.
- 1 8. The method of claim 1, wherein the compound having a group III element is
2 selected from the group consisting of AlCl_3 and $\text{Al}(\text{NO}_3)_3$.
- 1 9. The method of claim 1, wherein the catalyst mixture comprises one or more of
2 platinum, rhodium, rhenium, manganese, iron, aluminum, magnesium and
3 molybdenum.
- 1 10. The method of claim 1, wherein oxidizing the fuel comprises oxidizing the fuel in
2 an open flame.

- 1 11. The method of claim 1, wherein oxidizing the fuel comprises oxidizing the fuel in
2 an enclosed flame.
- 1 12. The method of claim 1, wherein oxidizing the fuel comprises oxidizing gasoline.
- 1 13. The method of claim 1, wherein oxidizing the fuel comprises oxidizing diesel
2 fuel.
- 1 14. The method of claim 1, wherein oxidizing the fuel comprises oxidizing a fuel
2 selected from the group consisting of number 2 fuel oil, fuel oil refined from
3 crude oil, diesel fuel, gasoline, compressed or liquified natural gas, gasohol, any
4 hydrocarbon having one or more carbon atoms such as methane, ethane, propane,
5 butane, isobutane, toluene, xylene, octane, benzene, mixtures of alcohols having
6 methanol, ethanol, propanol, butanol, isopropanol, isobutanol, pentanol, hexanol,
7 heptanol, octanol and combinations thereof, vegetable oil such as corn oil, mineral
8 oil, coal, coal gas, asphalt vapor, oxidizable vapors from chemical processes,
9 wood, paper and combinations thereof.
- 1 15. The method of claim 1, wherein oxidizing the fuel comprises oxidizing within a
2 combustion chamber of a reciprocating engine selected from the group consisting
3 of a gasoline fuel engine and a diesel fuel engine.

1 16. The method of claim 1, wherein oxidizing the fuel comprises oxidizing the fuel
2 within a combustion chamber of a reciprocating engine, wherein the fuel is
3 selected from the group consisting of number 2 fuel oil, fuel oil refined from
4 crude oil, diesel fuel, gasoline, compressed or liquified natural gas, gasohol, any
5 hydrocarbon having one or more carbon atoms such as methane, ethane, propane,
6 butane, isobutane, toluene, xylene, octane, benzene, mixtures of alcohols having
7 methanol, ethanol, propanol, butanol, isopropanol, isobutanol, pentanol, hexanol,
8 heptanol, octanol and combinations thereof, vegetable oil such as corn oil, mineral
9 oil, coal, coal gas, asphalt vapor, oxidizable vapors from chemical processes,
10 wood, paper and combinations thereof.

1 17. The method of claim 1, wherein oxidizing the fuel comprises oxidizing within a
2 flame zone of an apparatus selected from the group consisting of a furnace, a boiler
3 and an incinerator.

1 18. The method of claim 1, wherein oxidizing the fuel further comprises oxidizing
2 within an apparatus selected from the group consisting of an incinerator, a vent
3 gas burner, a furnace, a steam turbine and combinations thereof.

1 19. The method of claim 1, wherein providing the catalyst mixture further comprises
2 providing the catalyst mixture having a pH of less than about 4.0.

1 20. The method of claim 19, wherein providing the catalyst mixture further comprises
2 providing the catalyst mixture having a pH of between about 1.4 and about 3.0.

1 21. The method of claim 20, wherein providing the catalyst mixture further comprises
2 providing the catalyst mixture having a pH of between about 1.6 and about 2.2.

1 22. The method of claim 1, wherein the catalyst mixture comprises a concentration of
2 Pt, as $\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$ at least about 0.28 mg/ml, a concentration of Rh, as RhCl_3 at
3 least about 0.07 mg/ml, a concentration of Re, as perrhenic acid at least about 0.1
4 mg/ml, and a concentration of Al, as AlCl_3 at least about 0.07 mg/ml.

1 23. The method of claim 1, wherein the catalyst mixture comprises a concentration of
2 Pt, as $\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$ at least about 0.28 mg/ml, a concentration of Rh, as RhCl_3 at
3 least about 0.07 mg/ml, a concentration of Re, as perrhenic acid at least about 0.1
4 mg/ml, and a concentration of Mg as MgCl_2 at least about 0.07 mg/ml.

1 24. The method of claim 1, wherein the catalyst mixture further comprises a
2 surfactant.

- 1 25. The method of claim 2, wherein the liquid further comprises a surfactant.
- 1 26. The method of claim 1, wherein mixing a portion of the catalyst with the
2 combustion air comprises transporting the catalyst particles to a combustion air
3 intake to the flame zone and mixing the catalyst with the combustion air within
4 the air intake.
- 1 27. The method of claim 1, wherein a ratio of Pt to Rh in the mixture is between
2 about 15 to 1 and about 4 to 1, a ratio of Pt to Re in the mixture is between about
3 15 to 1 and about 2 to 1, and a ratio of Pt to Al in the mixture is between about 15
4 to 1 and about 2 to 1.
- 1 28. The method of claim 24, wherein the ratio of Pt to Rh in the mixture is about 8.6
2 to 1, the ratio of Pt to Re in the mixture is about 6 to 1, and the ratio of Pt to Al in
3 the mixture is about 8.6 to 1.

- 1 29. A catalyst mixture for use in the generation of fluidized catalyst particles for fuel
2 oxidation, the catalyst mixture comprising:
3 at least one compound having at least one element selected from the group
4 consisting of group III, group IIA and Lanthanide group; and
5 at least one compound having at least one element selected from the group
6 consisting of group IA, group IVA, group VI, group VII, group VIII,
7 group IB, group IIB and combinations thereof.
- 1 30. The catalyst mixture of claim 29, wherein the catalyst mixture comprises a
2 concentration of Pt, as $\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$ at least about 0.28 mg/ml, a concentration of
3 Rh, as RhCl_3 at least about 0.07 mg/ml, a concentration of Re, as perrhenic acid at
4 least about 0.1 mg/ml, and a concentration of Al, as AlCl_3 at least about 0.07
5 mg/ml.
- 1 31. The catalyst mixture of claim 29, wherein the catalyst mixture comprises a
2 concentration of Pt, as $\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$ at least about 0.28 mg/ml, a concentration of
3 Rh, as RhCl_3 at least about 0.07 mg/ml, a concentration of Re, as perrhenic acid at
4 least about 0.1 mg/ml, and a concentration of Mg as MgCl_2 at least about 0.07
5 mg/ml.

- 1 32. The catalyst mixture of claim 29, wherein the catalyst mixture further comprises
2 aqueous acid, wherein the catalyst mixture in aqueous acid has a pH of less than
3 about 4.0.
- 1 33. The catalyst mixture of claim 32, wherein the aqueous acid is aqueous
2 hydrochloric acid.
- 1 34. The catalyst mixture of claim 29, wherein the catalyst mixture in aqueous acid has
2 a pH of between about 1.4 and about 3.0.
- 1 35. The catalyst mixture of claim 29, wherein the catalyst mixture in aqueous acid has
2 a pH of between about 1.6 and about 2.2.
- 1 36. The catalyst mixture of claim 29, further comprising a liquid comprising
2 substantially equal parts of ethylene glycol and water.
- 1 37. The catalyst mixture of claim 35, further comprising one or more of LiCl, NaCl,
2 and HCl.

1 38. The catalyst mixture of claim 29, wherein the catalyst mixture further comprises a
2 surfactant selected from the group consisting of ethylene glycol, propylene glycol,
3 methanol, ethanol, propanol, butanol, pentanol, hexanol, isopropyl alcohol, isobutyl
4 alcohol, silicone oil, and combinations thereof.

1 39. The catalyst mixture of claim 29, wherein a ratio of Pt to Rh in the mixture is
2 between about 15 to 1 and about 4 to 1, a ratio of Pt to Re in the mixture is
3 between about 15 to 1 and about 2 to 1, and a ratio of Pt to Al in the mixture is
4 between about 15 to 1 and about 2 to 1.

1 40. The catalyst mixture of claim 39, wherein the ratio of Pt to Rh in the mixture is
2 about 8.6 to 1, the ratio of Pt to Re in the mixture is about 6 to 1, and the ratio of
3 Pt to Al in the mixture is about 8.6 to 1.

1 41. A fuel oxidation system comprising:
2 a flame zone for oxidizing fuel;
3 a catalyst chamber having a catalyst mixture therein, the catalyst mixture
4 comprising:
5 at least one compound having at least one element selected from the group
6 consisting of group III and group IIA; and
7 at least one compound having at least one element selected from the group
8 consisting of group IA, group IVA, group VI, group VII, group
9 VIII, group IB, group II and combinations thereof; and
10 a catalyst transport configured to transport catalyst particles from the catalyst
11 chamber to the flame zone.

1 42. The system of claim 41, wherein the flame zone is that of an open flame.

1 43. The system of claim 41, wherein the flame zone is that of an enclosed flame.

1 44. The system of claim 41, wherein the system is configured to oxidize a fuel
2 selected from the group consisting of gasoline and diesel fuel.

1 45. The system of claim 41, wherein the system is configured to oxidize a fuel
2 selected from the group consisting of number 2 fuel oil, fuel oil refined from
3 crude oil, diesel fuel, gasoline, compressed or liquified natural gas, gasohol, any
4 hydrocarbon having one or more carbon atoms such as methane, ethane, propane,
5 butane, isobutane, toluene, xylene, octane, benzene, mixtures of alcohols having
6 methanol, ethanol, propanol, butanol, isopropanol, isobutanol, pentanol, hexanol,
7 heptanol, octanol and combinations thereof, vegetable oil such as corn oil, mineral
8 oil, coal, coal gas, asphalt vapor, oxidizable vapors from chemical processes,
9 wood, paper and combinations thereof.

1 46. The system of claim 41, wherein the flame zone is a combustion chamber of a
2 reciprocating engine selected from the group consisting of a gasoline fuel engine
3 and a diesel fuel engine.

1 47. The system of claim 41, wherein the flame zone is a combustion chamber of a
2 reciprocating engine configured to oxidize a fuel is selected from the group

1 consisting of number 2 fuel oil, fuel oil refined from crude oil, diesel fuel,
2 gasoline, compressed or liquified natural gas, gasohol, any hydrocarbon having
3 one or more carbon atoms such as methane, ethane, propane, butane, isobutane,
4 toluene, xylene, octane, benzene, mixtures of alcohols having methanol, ethanol,
5 propanol, butanol, isopropanol, isobutanol, pentanol, hexanol, heptanol, octanol
6 and combinations thereof, vegetable oil such as corn oil, mineral oil, coal, coal
7 gas, asphalt vapor, oxidizable vapors from chemical processes, wood, paper and
8 combinations thereof.

- 1 48. The system of claim 41, wherein oxidizing the fuel comprises oxidizing within a
2 flame zone of an apparatus selected from the group consisting of a furnace, a boiler
3 and an incinerator.

1 50. A method of oxidizing fuel, the method comprising:
2 sparging a gas through a catalyst mixture comprising at least one Platinum
3 compound and at least one compound containing at least one of Aluminum
4 and Magnesium;
5 mixing catalyst mixture particles with combustion air prior to adding fuel; and
6 oxidizing fuel in the presence of the catalyst-containing combustion air.

1 51. The method of claim 50, wherein the sparging gas is selected from the group
2 consisting of helium, argon, nitrogen, air and combinations thereof.

1 52. The method of claim 50, further comprising ionizing the sparging gas prior to
2 sparging it through the catalyst mixture.

1 53. The method of claim 50, further comprising transporting the particles to a flame
2 zone under negative pressure.

1 54. The method of claim 50, further comprising establishing a catalyst mixture having
2 a pH of less than about 4.0 prior to sparging the gas through the catalyst mixture.

1 55. The method of claim 50, further comprising establishing a catalyst mixture having
2 a pH of between about 1.4 and about 3.0 prior to sparging the gas through the
3 catalyst mixture.

1 56. A catalyst mixture for oxidation of a fuel, the catalyst mixture comprising:
2 about 0.2.4 mg/ml of $\text{H}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$;
3 about 0.28 mg/ml of RhCl_3 ;
4 about 0.4 mg/ml of HReO_4 ; and
5 between about 0.28 mg/ml and about 0.56 mg/ml of at least one of AlCl_3 and
6 MgCl_2 .

1 57. The catalyst mixture of claim 56, wherein a ratio of Pt to Rh in the mixture is
2 between about 15 to 1 and about 4 to 1, a ratio of Pt to Re in the mixture is
3 between about 15 to 1 and about 2 to 1, and a ratio of Pt to Al or Mg in the
4 mixture is between about 15 to 1 and about 2 to 1.

1 58. The catalyst mixture of claim 57, wherein the ratio of Pt to Rh in the mixture is
2 about 8.6 to 1, the ratio of Pt to Re in the mixture is about 6 to 1, and the ratio of
3 Pt to Al or Mg in the mixture is about 8.6 to 1.

1 59. The catalyst mixture of claim 56, wherein the total volume of the catalyst mixture
2 is about 650 ml.

1 53. The catalyst mixture of claim 51, the liquid further comprising one or more of
2 HCl, NaCl, and LiCl.

1 54. The catalyst mixture of claim 53, wherein the liquid comprises approximately
2 5400 ppm of LiCl by weight.

1 55. The catalyst mixture of claim 49, further comprising hydrochloric acid.

1 56. The catalyst mixture of claim 49, wherein the catalyst mixture has a pH of less
2 than about 4.0.

1 57. The catalyst mixture of claim 49, wherein the catalyst mixture has a pH of
2 between about 1.2 and about 4.0.

1 58. The catalyst mixture of claim 49, wherein the catalyst mixture has a pH of
2 between about 1.4 and about 3.0.

- 1 59. The catalyst mixture of claim 49, wherein the catalyst mixture has a pH of
2 between about 1.6 and about 2.2.
- 1 60. The catalyst mixture of claim 49, wherein the catalyst mixture further comprises a
2 surfactant selected from the group consisting of ethylene glycol, propylene glycol,
3 methanol, ethanol, propanol, butanol, pentanol, hexanol, isopropyl alcohol, isobutyl
4 alcohol, silicone oil, and combinations thereof.